UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/274,194	03/22/1999	JOHN E. LANG	LAM2P266	8105

7590 03/17/2005

MARTINE & PENILLA, LLP
710 Lakeway Drive
Suite 170
Sunnydale, CA 94085

EXAMINER	
SONG, MATTHEW J	

ART UNIT	PAPER NUMBER
1765	

DATE MAILED: 03/17/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/274,194	LANG, JOHN E.	
	Examiner	Art Unit	
	Matthew J Song	1765	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 12/17/2004.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 20-38 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 20-38 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 20-22, 26-28, and 32-33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wojnarowski et al (US 5,302,547) or Huang et al (US 6,191,028) in view of Chen et al (US 5,700,740).

Wojnarowski et al discloses providing a semiconductor substrate **10**, forming a low dielectric constant layer **18** on a surface of the semiconductor layer, forming a hard mask layer **38** over the low dielectric constant layer, forming a photoresist layer **40** over the hard mask layer and forming openings **44** through the entire thickness of the hard mask layer exposing the low dielectric constant layer (col 8, ln 45 to col 9, ln 25 and Figs 5(a)-5(c)). Wojnarowski et al also discloses removing the photoresist layer from over the hard mask layer (col 9, ln 15-25). Wojnarowski et al also discloses the low dielectric constant layer **18** can be formed of TEFLON polytetrafluoroethylene (col 8, ln 66 to col 9, ln 1), this reads on applicant's organic low dielectric constant layer.

Huang et al discloses a method of patterning a dielectric comprising a substrate **10**, a low dielectric constant layer **12**, a hard mask **13**, a photoresist layer **14** and forming an opening through an entire thickness of the hard mask layer exposing the low dielectric constant layer.

Huang et al also teaches the photoresist layer is removed using a plasma containing oxygen (col 1, ln 25-55). Huang et al also teaches the low dielectric layer comprises organic polymers, such as parylene (col 1, ln 25-35).

Wojnarowski et al is silent to the method used to remove the photoresist layer. Huang et al teaches removing the photoresist layer using oxygen plasma.

In a method of fabricating integrated circuits on a semiconductor substrate of silicon, note entire reference, Chen et al teaches a silicon substrate **2** and photoresist film **5** is deposited thereon on and patterned (column 3, lines 30-67). Chen et al also teaches the photoresist is stripped off by using an oxygen plasma or a suitable solvent such as ACT-690, which is photoresist stripper consisting of a mixture of dimethyl-sulfoxide (column 4, ln 25-40). This reads on applicant's limitation of removing the photoresist layer from the over the hard mask layer with dimethyl sulfoxide of a high-pressure liquid chromatography (HLPC) grade.

Because Wojnarowski et al does not teach any particular means for removing the photoresist, any conventional means of removing photoresist would be applicable. Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Wojnarowski et al by using the conventional means of removing photoresist using dimethyl-sulfoxide, as taught by Chen et al and ACT-690 is known to selectively remove a photoresist mask without attacking a low dielectric layer.

Chen et al teaches using dimethyl sulfoxide or an oxygen plasma to remove photoresist, this is a teaching that using dimethyl sulfoxide or an oxygen plasma are equivalent methods of removing photoresist. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Huang et al by using dimethyl sulfoxide to remove the

photoresist as taught by Huang et al because substitution of known equivalents for the same purpose is held to be obvious (MPEP 2144.06) and ACT-690 is known to selectively remove a photoresist mask without attacking a low dielectric layer.

Unlike the claimed invention, neither the combination of Wojnarowski et al and Chen et al or the combination of Huang et al and Chen et al teaches a method wherein a high selectivity of the dimethyl sulfoxide of HPLC grade toward a low dielectric constant material of the low dielectric constant layer causes the dimethyl sulfoxide to chemically dissolve the photoresist layer from over the hard mask layer without substantially damaging the low dielectric constant layer. Chen et al does teach the dimethyl sulfoxide chemically dissolved the photoresist layer. Since the dimethyl sulfoxide layer chemically dissolves the photoresist layer and the same process steps are performed, it is inherent that the dimethyl sulfoxide has a high selectivity toward a low dielectric constant material, absent evidence to the contrary. Furthermore, Liu et al (US 6,150,272) teaches a low dielectric polymer layer is not attacked when using an ACT-690 solution to remove a photoresist.

Referring to claim 21-22, the combination of Wojnarowski et al and Chen et al teaches Teflon, which inherently has a dielectric constant of 3.0 or less, as evidenced by Subramanian et al (US 6,596,623) and Cheung et al (US 5,670,828) below. The combination of Huang et al and Chen et al teaches parylene, which inherently is within the claimed range, note page 7 of the instant specification.

3. Claims 23-25, 29-31 and 34-38 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wojnarowski et al (US 5,302,547) or Huang et al (US 6,191,028) in view of Chen et al (US

5,700,740) as applied to claims 20-22, 26-28, and 32-33 above, and further in view of Fujimura et al (US 4,861,732).

The combination of Wojnarowski et al and Chen et al or the Huang et al and Chen et al teaches all of the limitations of claim 23, as discussed previously, except the semiconductor substrate is held in an ultrasonic bath.

In a method fabricating a semiconductor bath, Fujimura et al teaches for the removal of the resist layer a substrate is immersed for about five minutes in an etchant and it is preferable to stir the solvent by applying an ultrasonic wave in order to improve the efficiency of the reaction, this reads on an applicant's ultrasonic bath. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Wojnarowski et al and Chen et al or the Huang et al and Chen et al with Fujimura et al's ultrasonic wave to improve the efficiency of the solvent.

Referring to claim 24, the combination of Wojnarowski et al, Chen et al and Fujimura et al or the Huang et al, Chen et al and Fujimura et al is silent to the temperature of the bath. Temperature is well known in the art to be a result effective variable. Therefore, It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Wojnarowski et al, Chen et al and Fujimura et al or the Huang et al, Chen et al and Fujimura et al by optimizing temperature by conducting routine experimentation of a result effective variable (MPEP 2144.05). Also, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation. (In re Aller, 220 F.2d 454, 456, 105 USPQ 233, 235(CCPA 1955)).

Furthermore, heating dimethyl sulfoxide to 80°C to remove photoresists is conventionally known in the art, as evidenced by Martin et al (US 4,304,681) below.

Referring to claim 25, the combination of Wojnarowski et al, Chen et al and Fujimura et al or the Huang et al, Chen et al and Fujimura et al is silent to the duration of the bath. Minimizing the bath time would be desirable to improve productivity. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Wojnarowski et al, Chen et al and Fujimura et al or the Huang et al, Chen et al and Fujimura et al by optimizing the bath time to be a minimum by conducting routine experimentation of a result effective variable (MPEP 2144.05). Furthermore, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation. (In re Aller, 220 F.2d 454, 456, 105 USPQ 233, 235(CCPA 1955)).

4. Claims 20-22, 26-28, and 32-33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wojnarowski et al (US 5,302,547) or Huang et al (US 6,191,028) in view of Liu et al (US 6,150,272).

Wojnarowski et al and Huang et al teaches all of the limitations of claim 20, as discussed previously, except method used to remove the photoresist layer.

In a method of removing a photoresist layer, Liu et al teaches a photoresist mask is removed selectively to an organic low dielectric polymer layer using a solvent such as ACT-690 manufactured by Ashland Chemical of USA (col 4, ln 15-45 and claims 10 and 18) without attacking the low dielectric layer, this reads on applicant's Dimethyl sulfoxide because ACT-690

comprises DMSO, as evidenced by Chen et al (US 5,700,740) above. This reads on applicant's limitation of removing the photoresist layer from the over the hard mask layer with dimethyl sulfoxide of a high pressure liquid chromatography (HLPC) grade. Liu et al also teaches using FLARE as a low dielectric polymer. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Wojnarowski et al or Huang et al with Liu et al's photoresist solvent comprising dimethyl sulfoxide because the low dielectric layer is not attacked and the photoresist is removed selectively.

5. Claims 23-25, 29-31 and 34-38 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wojnarowski et al (US 5,302,547) or Huang et al (US 6,191,028) in view of Liu et al (US 6,150,272) as applied to claims 20-22, 26-28, and 32-33 above, and further in view of Fujimura et al (US 4,861,732).

The combination of Wojnarowski et al and Liu et al or the Huang et al and Liu et al teaches all of the limitations of claim 23, as discussed previously, except the semiconductor substrate is held in an ultrasonic bath.

In a method fabricating a semiconductor bath, Fujimura et al teaches for the removal of the resist layer a substrate is immersed for about five minutes in an etchant and it is preferable to stir the solvent by applying an ultrasonic wave in order to improve the efficiency of the reaction, this reads on an applicant's ultrasonic bath. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Wojnarowski et al and Liu et al or the Huang et al and Liu et al with Fujimura et al's ultrasonic wave to improve the efficiency of the solvent.

Referring to claim 24, the combination of Wojnarowski et al, Liu et al and Fujimura et al or the Huang et al, Liu et al and Fujimura et al is silent to the temperature of the bath. Temperature is well known in the art to be a result effective variable. Therefore, It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Wojnarowski et al, Liu et al and Fujimura et al or the Huang et al, Liu et al and Fujimura et al by optimizing temperature by conducting routine experimentation of a result effective variable (MPEP 2144.05). Also, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation. (In re Aller, 220 F.2d 454, 456, 105 USPQ 233, 235(CCPA 1955)). Furthermore, heating dimethyl sulfoxide to 80°C to remove photoresists is conventionally known in the art, as evidenced by Martin et al (US 4,304,681) below.

Referring to claim 25, the combination of Wojnarowski et al, Liu et al and Fujimura et al or the Huang et al, Liu et al and Fujimura et al is silent to the duration of the bath. Minimizing the bath time would be desirable to improve productivity. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Wojnarowski et al, Liu et al and Fujimura et al or the Huang et al, Liu et al and Fujimura et al by optimizing the bath time to be a minimum by conducting routine experimentation of a result effective variable (MPEP 2144.05). Furthermore, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation. (In re Aller, 220 F.2d 454, 456, 105 USPQ 233, 235(CCPA 1955)).

Response to Arguments

6. Applicant's arguments filed 12/17/2004 have been fully considered but they are not persuasive.

Applicant's argument that Wojnarowski is silent to removing the photoresist layer from over the low constant dielectric without substantially damaging the low dielectric constant layer is noted but is not found persuasive. The Examiner admits that Wojnarowski is silent to this feature, however in view of Chen et al's teaching of using dimethyl sulfoxide, removing the photoresist layer from over the low constant dielectric layer without substantially damaging the low dielectric constant layer would be inherent. The Examiner has also provided reasoning supporting this position and Liu et al also supports the Examiner's inherency position, as stated previously in the rejection.

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references (pg 8, first paragraph). See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Chen is not relied upon to teach the low constant dielectric. Chen is relied upon solely to teach a method of removing a photoresist layer using dimethyl sulfoxide. Wojnarowski or Huang et al teach the low constant dielectric.

Applicant's argument that Wojnarowski discourages one of ordinary skill in the art to implement dielectric with high density is noted but is not found persuasive. Wojnarowski is relied upon to teach a photoresist layer on a low constant dielectric and removing the photoresist from the low constant dielectric. Chen is relied upon solely to teach a method of removing

photoresist using dimethyl sulfoxide. Wojnarowski does not discourage a person of ordinary skill in the art from using dimethyl sulfoxide to remove the photoresist.

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references (pg 8, second full paragraph). See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Fujimura is not relied upon to teach using a low dielectric constant material over a silicon substrate and removing the photoresist from over such low K dielectric layer. Fujimura is relied upon to teach using an ultrasonic bath.

Applicant's argument that Huang et al teaches away from using oxygen plasma to remove photoresist (pg 9, first full paragraph) is noted but is not found persuasive. Huang et al merely teaches a process, which is an improvement over the prior art process. Huang et al does not teach away from using oxygen plasma to remove photoresist, as suggest by applicant. Huang et al teaches the prior art using oxygen plasma to remove photoresist (col 1, ln 45-60) and Huang et al also teaches using oxygen plasma to remove photoresist in the improved process (col 3, ln 35-40; col 4, ln 15-20; Fig 2C and Fig 3C). Huang et al does not teach away from using oxygen plasma to remove photoresist because Huang et al teaches using oxygen plasma to remove photoresist.

Applicant's argument that Liu has statements, which contradict one another, is noted but is not found persuasive. Applicant's allege that Liu teaches ACT-690 selectively removes the organic protective layer without the ACT-690 attacking the low-dielectric layer and Liu also teaches the ACT-690 was used to remove the photoresist layer, which is contradictory to the first

statement. The Examiner does not agree with the Applicant's interpretation of the Liu reference. Liu teaches the photoresist mask is removed selectively to the low-dielectric polymer layer **16** (col 4, ln 39-45). Liu et al also teaches layer **16** is removed by plasma ashing in O_2 and "**Alternatively**, a wet cleaning in a solution of ACT-690 **can be included to further clean** the substrate surface", note column 5, lines 10-15. The ACT-690 is not used to remove the photoresist, but is provided to **further** clean the surface after the O_2 ashing. Therefore, Liu does not teach contradictory statements.

Conclusion

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Subramanian et al (US 6,596,623) teaches low dielectric organic materials include parylene (dielectric constant of 2.3-3.1), Teflom (dielectric constant of 1.8-2.1) and polyimidies having a dielectric constant of about 3.0. (col 4, ln 30-40).

Cheung et al (US 5,670,828) teaches polyimidies generally exhibit a dielectric constant of about 2.4-3.9 and Teflon exhibits a dielectric constant of about 1.6 to about 2.2 (col 1, ln 40-50).

Martin et al (US 4,304,681) teaches heating dimethyl sulfoxide to 80°C to remove a photoresist layer (Example 1).

8. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 571-272-1468. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on 571-272-1465. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Matthew J Song

Examiner
Art Unit 1765

MJS
March 8, 2005

NADINE G. NORTON
SUPERVISORY PATENT EXAMINER